DOCUMENT RESUME

ED 264 095 SE 046 255

TITLE	Conserving Electrical Energy in Commerce and Industry. Science and Technology Education in Philippine Society.
INSTITUTION	Philippines Univ., Quezon City. Inst. for Science and Mathematics Education Development.
SPONS AGENCY	Educational Development Projects Implementing Task Force (Philippines).
REPORT NO	ISBN-971-135-096-3
PUB DATE	Jul 85
NOTE	29p.; For other documents in this series see SE 046 256-274.
AVAILABLE FROM	University of the Philippines, Institute for Science and Mathematics Education Development, Pardo de Tavera St., Diliman, Quezon City, Philippines ($3.00).
PUB TYPE	Guides - Classroom Use - Materials (For Learner) (051)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Electricity; *Energy Conservation; Energy Education; Foreign Countries; *Fuel Consumption; Fuels; High Schools; *Industry; Science Education; *Secondary School Science
IDENTIFIERS	*Philippines

ABSTRACT

This module contains readings which explain the need to conserve electricity and describe how major electric energy users (the industrial and commercial groups) use and conserve electricity. The module also contains 10 self-check questions (with answers) and a list of references. Students completing the module should be able to: (1) compare the percent of electric consumption of different groups; (2) describe how individuals depend on oil as a source for generating electricity and understand the implications of such dependence; (3) recognize the trends in the contribution of different sources in producing electric energy and realize the importance of such trends; (4) describe how selected examples of commercial and industrial firms use and conserve electricity; (5) discuss how the government helps the commercial and industrial groups to conserve energy; and (6) discuss the importance of the combined efforts of all groups to conserve electricity. (JN)

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Conserving Electrical Energy in Commerce and Industry

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Conserving Electrical Energy in Commerce and Industry

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ISBN 971-135-096-3

Published and printed by the

INSTITUTE FOR SCIENCE AND MATHEMATICS EDUCATION DEVELOPMENT
Vidal A. Tan Hall
University of the Philippines
Diliman, Quezon City

July, 1985

CONSERVING ELECTRICAL ENERGY IN COMMERCE AND INDUSTRY

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Conserving Electrical Energy in Commerce and Industry

An energy conservation slogan used to be heard over the radio and television was:

"Half of the energy source for electricity
is bought with dollars.
Let's save electricity.
Let's save dollars."

Saving dollars is one reason for conserving electricity. We import oil to generate electricity. A more important reason concerns the limited supply of oil – the main source of electric energy. Considering these factors, this module explains the need to conserve electricity. It also describes how two major electric energy users – the industrial and commercial groups – use and conserve electricity.

After studying this module, you should be able to:

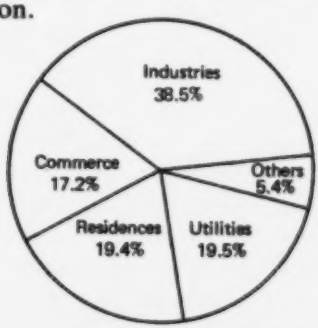
1. compare the percent of electric consumption of different groups
2. describe how we depend on oil as source for generating electricity and give implications of such dependence
3. recognize the trends in the contribution of different sources in producing electric energy and realize the importance of such trends
4. describe how examples of commercial and industrial firms use and conserve electricity
5. discuss how the government helps the commercial and industrial groups to conserve energy
6. discuss the importance of the combined efforts of all groups to conserve electricity

OUR ELECTRIC ENERGY USE

Users of electricity fall under 5 classifications. Examples of each are given below.

1. Residences – houses, apartments
2. Commerce – schools, hotels, restaurants, hospitals
3. Industries – textile factories, food processing plants
4. Electric utilities – electric power companies like the National Power Corporation (NPC) and Zamboanga City Electric Cooperative (ZAMCELCO)
5. Others – government offices, street lights, water and irrigation companies

In 1982, all the sectors consumed about 19 406 billion kilowatt-hours (19 406 BkWh)*. The circle graph below shows their percent consumption.



1982 Electric Consumption by Groups (%)

The consumption of the industries accounted for almost 40% of the total electric consumption. This was

$$38.5\% \text{ of } 19\,406 \text{ BkWh} = 19\,406 \text{ B kWh}$$
$$= 7\,471.31 \text{ B kWh}$$

The consumption of the other sectors were:

Residences	3 764.76 B kWh
Commerce	3 337.83 B kWh
Electric utilities	3 784.17 B kWh
Others	1 047.92 B kWh

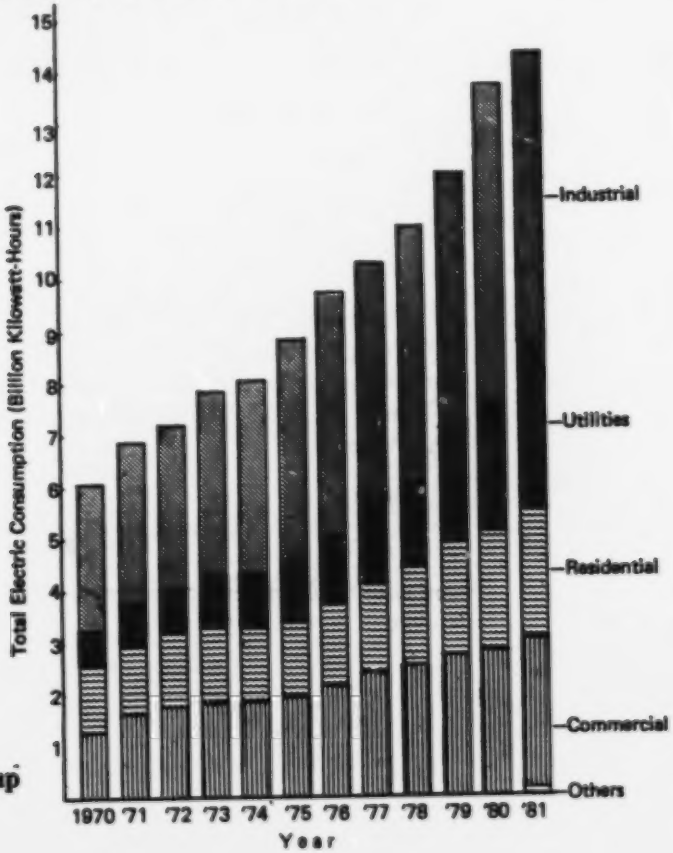
*See Appendix A for the explanation of this notation.

The industries used

$$\frac{7\,471.31\ \text{B kWh}^*}{3\,764.76\ \text{B kWh}} = 1.98$$

or about twice as much electricity than the residences. Compared to the rest of the sectors, its consumption was about 2.24 times as much as that of commerce, 1.97 times that of the electric utilities and 7.13 times that of government offices and others.

The industries have consistently used more electric energy than the other groups. The graph below shows this.



Electric Consumption by Group 1970-1981

*See Appendix A for the cancellation of units.

Electric energy comes from different sources (Table 1).

Table 1. Sources of Electric Energy, 1977 to 1982
(In million barrels of oil equivalent, MMBOE)

SOURCE	YEAR					
	1977	1978	1979	1980	1981	1982
Coal	0.2	0.1	0.3	0.4	0.3	0.6
Geothermal	—	—	1.3	3.9	4.8	6.2
Hydro	3.6	4.6	5.8	6.2	6.4	6.6
Non-conventional	—	—	—	—	0.6	0.6
Oil	17.1	21.0	20.7	20.5	19.9	20.0
TOTAL	20.9	25.7	28.1	31.0	32.0	34.0

The unit is million barrels of oil equivalent (MMBOE). One barrel of oil generates 600 kWh of electricity. Based on this, electric consumption may be described in terms of equivalent barrels of oil.

In 1977, 0.2 MMBOE of electricity came from coal. Using the proportion

$$\frac{x}{0.2\text{ million BOE}} = \frac{600\text{ kWh}}{1\text{ BOE}}$$

the amount of electricity generated by coal, represented by x, can be solved.

$$x = \frac{0.2\text{ million }\cancel{\text{BOE}} \times 600\text{ kWh}^*}{1\,\cancel{\text{BOE}}}$$

$$= 120.0\text{ million kWh or } 120.0\text{ M kWh.}$$

*See Appendix A for multiplication of units.

Each year oil consistently supplied the biggest amount of electric energy as can be seen from the table. The percent contribution of oil for 1977 was

$$\frac{17.1\,\text{MMBOE}}{20.9\,\text{MMBOE}} \times 100\% = 81.8\%.$$

For 1978 to 1982, these were 81.7%, 73.7%, 66.1%, 62.2% and 58.8%, respectively. Notice that oil use for electric generation has been decreasing. However, as of 1982 more than half of our electric energy needs was still met solely by oil.

Table 2 shows our total oil consumption due to both our electric and nonelectric needs.

Table 2. National Oil Consumption
(In Million Barrels)

Source	1977	%	1978	%	1979	%	1980	%	1981	%	1982	%
Imported	78.5	100.0	81.1	100.0	76.7	90.8	73.7	95.1	67.1	98.0	66.5	96.7
Domestic	–	–	–	–	7.8	9.2	3.8	4.9	1.4	2.0	2.3	3.3
Total	78.5	100.0	81.1	100.0	84.5	100.0	77.5	100.0	68.5	100.0	68.8	100.0

Observe the entries in the columns under %. These figures indicate that we buy practically all the oil we use from other countries. This kind of dependence on imported oil has important implications. For instance, a reduction in imported oil use in 1982 of just 10% would have saved us about 7 M barrels of oil. At the average price of $34 a barrel then, this was close to $238 M. Such amount can surely build a lot of schools, houses, hospitals and kilometers of farm to market roads.

The price of oil keeps on increasing. From $4 a barrel in 1973, it has become $34 a barrel in 1982. And in 1982, for every dollar we earn from export, about 40% was used to pay our oil import bill. Reducing our imported oil expenses can increase our funds for development projects.

In 1981, there was more supply of oil than demand for it. This caused oil to be sold cheaper. Despite this, the cost of our oil imports did not go down because our peso has a low value compared to the

dollar and we pay our imports in dollars. In fact, the cost in pesos of our oil imports increased by around 10%!

Recall the slogan at the beginning of this module. Is it more meaningful to you now?

Oil has properties that contribute to the problem of uncertainty in supply. It takes a very long time, in fact MILLIONS OF YEARS, to form a drop of oil. But it is easily consumed. It takes LESS THAN A SECOND to burn a drop. Besides these, oil is nonrenewable.

Because of the rapid increase in population and generally heavy industrialization in the world at present, oil is now being used up faster than before. In 1981, the known oil deposit of the world was estimated to range from 1 B to 2 B barrels. While new oil deposits may be discovered, definitely there is lesser oil now than years ago. Conserving electricity is one way of slowing down the depletion of oil to give time for the development of renewable sources.

Our country has taken these realities seriously. Notice in Table 1 that the use of coal in 1982 became 3 times as much that in 1977. The increase was

$$\frac{(0.6-0.2)\,\text{MMBOE}^*}{0.2\,\text{MMBOE}} \times 100\% = \frac{0.4}{0.2} \times 100\%$$

$$= 200\%.$$

For other sources, the corresponding increases in 5 years were: for geothermal (377%), for hydro (83.3%), for non-conventional (0%) and for oil (17.0%). The aim is to increase the use of these other sources including nuclear energy and minimize the use of oil.

ELECTRIC ENERGY USE AND CONSERVATION IN COMMERCE AND INDUSTRY

In line with the country's energy conservation program, the different groups have been observing measures particularly in electric energy use. In the commercial group, an example is an eight-story bulding in one of our cities. In July 1983, it consumed 77 400 kWh. The use followed the general monthly breakdown: about 80% was due to aircon-

*See Appendix A for the reason of this computation.

ditioning, about 15% to lighting and about 5% to various equipment like elevators and typewriters. The office began its conservation program in 1981 with the supervision of its maintenance department. Here are the ways it conserves electricity.

Airconditioning and Lighting

1. Temperature regulators or thermostats were enclosed in boxes with locks so only the maintenance department can set them.
2. Out of an average of 6 airconditioners per floor, only 4 in each floor are used during cold months. Thermostats are set to about 23° C. All units are used during warm days with thermostats set to about 22° C.

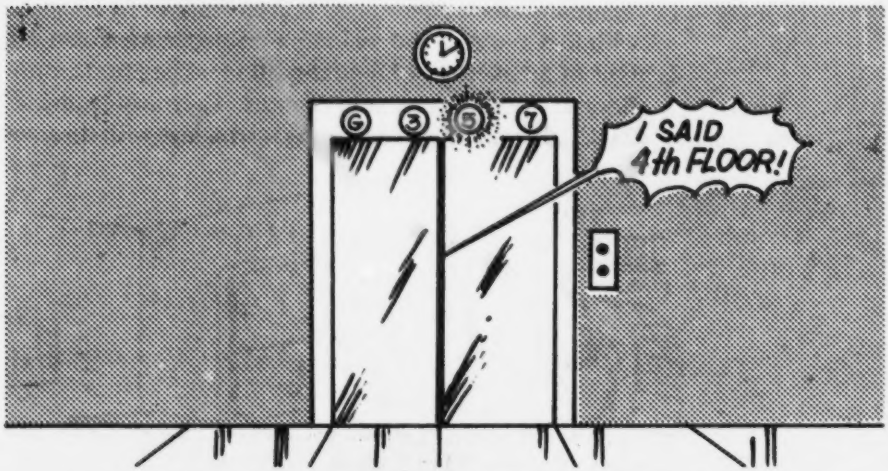
3. In areas where there are no people, lights are turned off. Airconditioners are still switched on.
4. There is a fixed schedule for using airconditioners. During lunch breaks, airconditioners and lights are switched off.

Equipment

1. Only executive secretaries use electric typewriters. The others use manual typewriters.
2. Duplicating machines are turned off when not being used. These have transformers which consume much electricity when left switched on.

Aside from these, the office is making the following studies:

1. To encourage people to use the stairs in going up or down one floor, two sets of elevators are used. One starts from the ground floor then goes to the third, fifth and seventh floors. The other starts from the ground floor then goes to the fourth, sixth and eighth floors.



2. Tinted glass windows are used. Not only do they keep away the sun's glare but also reflect solar heat, thereby reducing the work of the airconditioners.

As a result of these efforts, the yearly consumption of the office became nearly 10% less than that in 1980.

An example of an industry that conserves electricity is a food processing firm in one of our urban cities. It used 1.332 M kWh in August 1983. Its electric bill was ₱1.155 M. The following are its electric energy conservation measures.

In the Plant Division Office

1. Electric fans are used instead of airconditioners.
2. Lamp fixtures with reflectors that increase lighting effect are used.
3. Lights and electric fans are turned off whenever people are out in the plant.

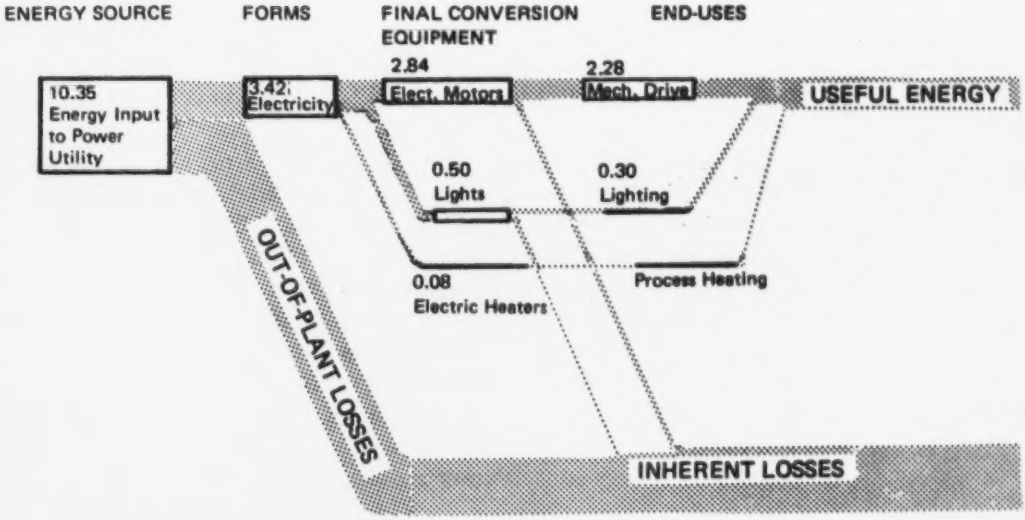
In the Plant

1. Roofing includes plastic roofs to make full use of natural light.
2. The right machines for the right jobs are used.
3. Proper maintenance of equipment is observed.

For additional tips in conserving electricity for commercial and industrial groups, refer to Appendix B.

The diagram below shows how a milk canning firm in the country uses electricity. The industry consumes an average of 0.518 M kWh per month.

Estimated Electric Energy Flow and Inherent Losses in a Milk Canning Plant, 1979
(In Thousand Barrels of Oil Equivalent, MBOE*)



*See Appendix for this notation.

An electric power plant supplies the milk canning firm with electricity. The plant uses 10.35 MBOE of energy to generate electricity. However, only 3.42 MBOE of energy in the form of electricity goes to the firm. This is about

$$\frac{3.42\,\cancel{\text{MBOE}}}{10.35\,\cancel{\text{MBOE}}} \times 100\% = 33.0\%$$

Energy of about 67.0% was wasted in the process and is known as out-of-the plant losses.

Electric energy is then converted by electric motors to drive machines, by lights for lighting and by electric heaters to provide heat needed by some processes. During conversion, some amounts of electricity are lost and wasted. The only useful energy, therefore, is

$$\frac{(2.28 + 0.30 + 0.06^{*})\,\cancel{\text{MBOE}}}{10.35\,\cancel{\text{MBOE}}} \times 100\% = \frac{2.64}{10.35} \times 100\%$$

$$= 25.5\%.$$

This means that only a little over one fourth of the energy originally put in became useful.

Losses such as those in this milk canning firm are common in many industries and also in commercial establishments. To minimize these losses, an "energy audit" is being done. This program helps to identify why and where wastage occurs. Findings become bases for necessary conservation measures. Moreover, the Batasang Pambansa passed an energy conservation law institutionalizing energy conservation in large energy consumers like the industrial and commercial groups. The law requires them to employ engineers who aside from designing, implementing and monitoring the energy conservation programs of the company, must conduct energy audits. Training courses on energy conservation are also conducted for these personnel.

We have considered the amount of electric consumption by groups. In reality, the consumption of any group may affect the consumption of the others. Suppose the commercial group reduced its

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No information is given on the amount of electricity that becomes useful for heating purposes. Let's just suppose that 0.06 MBOE or 75% of the electricity that goes to the electric heaters becomes useful.

electric use by 10%. Then, the utility companies would use less energy to meet the needs of the group. A reduction in the use of any group reduces the total consumption.

For reference, the 1982 electric consumption is given here again.

GROUP	1982 Electric Consumption (In billion kWh)
Residences	3764.76
Commerce	3337.83
Industries	7471.31
Utilities	3784.17
Others	1047.92
TOTAL	19405.99

Suppose the consumption of the commercial group decreased by 5%.

$$\begin{aligned} \text{Amount of decrease} &= 5\% \text{ of } 3337.83 \text{ B kWh} \\ &= 0.05 \times 3337.83 \text{ B kWh} \\ &= 166.89 \text{ B kWh.} \end{aligned}$$

So, the new total consumption is

$$(19\,405.99 - 166.89) \text{ B kWh} = 19\,239.10 \text{ B kWh.}$$

It reduced by

$$\frac{166.89 \cancel{\text{B kWh}}}{19\,405.99 \cancel{\text{B kWh}}} \times 100\% = \frac{166.89}{19\,405.99} \times 100\% = 0.86\%$$

which is less than 1.0%.

If the reduction in the use of the commercial group is doubled then,

$$\begin{aligned} \text{amount of decrease} &= 10\% \text{ of } 3337.83 \text{ B kWh} \\ &= 0.10 \times 3337.83 \text{ B kWh} \\ &= 333.78 \text{ B kWh.} \end{aligned}$$

The new total consumption is

$$(19\,405.99 - 333.78)\ \text{B kWh} = 19\,072.21\ \text{B kWh}.$$

The total consumption reduced by

$$\frac{333.78\ \cancel{\text{B kWh}}}{19\,406.99\ \cancel{\text{B kWh}}} \times 100\% = 1.72\%.$$

The table below summarizes the effect of a reduction on the consumption of the different groups on the total consumption.

	(1)	(2)	(3)	(4)
GROUP	**5% decrease in use (BkWh)**	**Decrease in total use due to a 5% decrease in use (%)**	**10% decrease in total use (BkWh)**	**Decrease in total use due to a 10 % decrease in use (%)**
Residences	188.24	0.97	376.48	1.94
Commerce	166.89	0.86	333.78	1.72
Industries	373.56	1.92	747.13	3.85
Utilities	189.21	0.98	378.42	1.95
Others	52.40	0.27	104.79	0.54
Total	970.30	5.00	1940.60	10.00

Observe that the entries on the third column are twice those on the first while the entries on the fourth are twice those on the second. This means that

as the percent decrease in the consumption of a group doubles, the amount of reduction and the percent decrease on the total consumption also double.

A 5% decrease in the use of the commercial group together with a 5% decrease in that of the industrial group would decrease the total use by

$$\frac{(166.89 + 373.56)\ \cancel{\text{B kWh}}}{19\,405.99\ \cancel{\text{B kWh}}} \times 100\% = \frac{540.45}{19\,405.99} \times 100\%$$

$$= 2.78\%.$$

Notice that 2.78% = 0.86% + 1.92%. (See table on the previous page.)

If all the sectors reduced their consumption by 5% each, the total consumption would reduce by 5%. Let RC, CC, IC, UC and OC stand for the consumption of the residences, commerce, industries, utilities and others respectively. Then

$$\begin{aligned} &5\% \text{ of } RC + 5\% \text{ of } CC + 5\% \text{ of } IC + 5\% \text{ of } UC + 5\% \text{ of } OC \\ &= 0.05 \times RC + 0.05 \times CC + 0.05 \times IC + 0.05 \times UC + 0.05 \times OC \\ &= 0.05 \times (RC + CC + IC + UC + OC). \end{aligned}$$

But the sum of the consumptions of all the sectors is just the total consumption (TC). That is,

$$RC + CC + IC + UC + OC = TC.$$

So,

$$0.05 \times (RC + CC + IC + UC + OC) = 0.05 \times TC.$$

Thus, if all sectors would use electric energy wisely, then the total consumption would reduce considerably.

While we have considered the users of electricity by groups, in general, all electric energy use is within an individual's personal control.

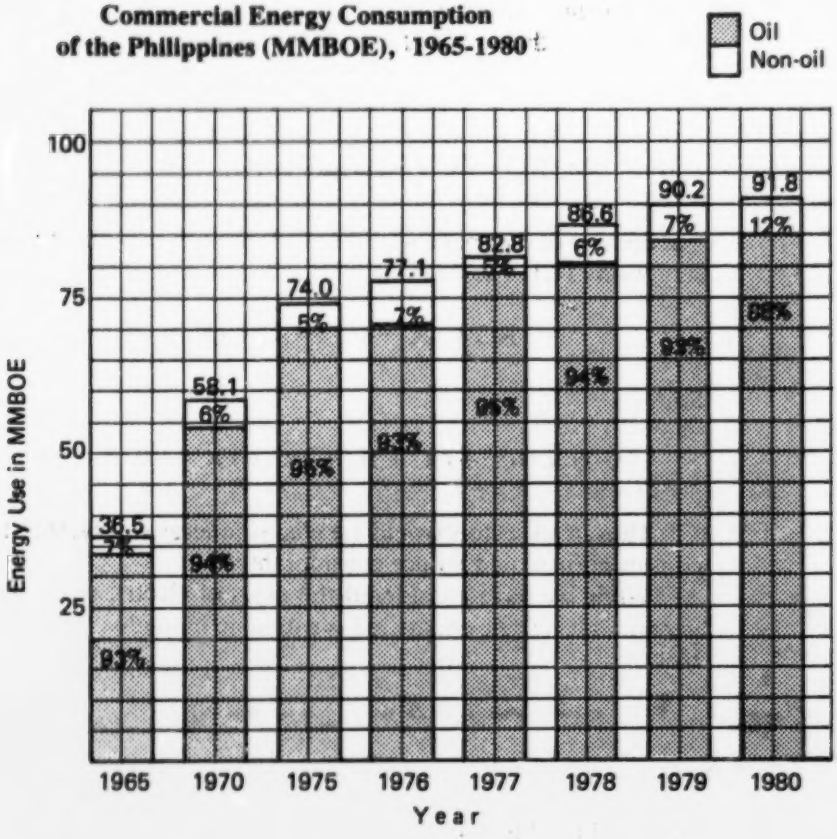
SELF-CHECK

1. Consider this claim:

   "More remote places have now been reached by electricity. And more industries are now being built in the provinces. Because of this, in 1985, the percent increase in electric consumption will be higher in Visayas and Mindanao at 17.0% and 14.2%, respectively. Luzon will only have 7%."

   Does the statement mean that the amount of electric consumption in Luzon will be the least? Explain briefly.

The graph below shows our dependence on oil for our electric and nonelectric needs.



The graph for instance means that in 1965, 36.5 MMBOE of energy was consumed, 93% of which came from oil while 7% came from non-oil sources. Refer to the graph to answer questions 2 to 4.

2. In 1965, how many MMBOE of the energy consumed came from oil? How many came from non-oil sources?
3. How many times as much was the 1980 oil use compared to that 15 years ago?

4. The energy used which came from oil was both 94% in 1970 and 1978. Was the amount of oil used in those years the same? Explain briefly.

To make us more energy self-reliant, local sources like coal and geothermal sources are now being developed. Demands for these sources are expected to increase. Use the table below to answer questions 5 and 6.

Energy Demand 1983-1985 (MMBOE)

SOURCE	DEMAND	
	1983	1985
Coal	8.96	14.51
Geothermal	7.64	9.59

5. By how many percent will the demand for coal grow in 1985?
6. Will the use of geothermal energy increase by more than one fourth in 1985?

The 1982 electric consumption is given here once more. Refer to the table below for questions 7 to 10.

GROUP	1982 Electric Consumption (In billion kWh)
Residences	3764.76
Commerce	3337.83
Industries	7471.31
Utilities	3784.17
Others	1047.92
TOTAL	19405.99

7. If the consumption of the commercial sector increased by 5%, how many percent would the total consumption increase?
8. What would be the total consumption after a 5% increase in the consumption of the commercial sector?

9. If the use of the commercial sector increased by 10%, how many percent would the total consumption increase?
10. Compare the percent increases in the total consumption when the use of the commercial sector increased by 5% and 10%.

APPENDIX A

1. Writing Big Numbers in Shorter Form

Big numbers are usually written in shorter form. Examples are those with 7 or more digits. In the shorter form, a number is followed by the letter M or B. M stands for million and B for billion. The number is multiplied either by 1 million or 1 billion depending on what letter follows it. For instance,

$$\begin{aligned} 19\,406\text{ B kWh} &= 19\,406 \times 1\,000\,000\,000\text{ kWh} \\ &= 19\,406\,000\,000\,000\text{ kWh} \end{aligned}$$

and

$$\begin{aligned} 7\,471.31\text{ B kWh} &= 7\,471.31 \times 1\,000\,000\,000\text{ kWh} \\ &= 7\,471\,310\,000\,000\text{ kWh.} \end{aligned}$$

In this module, MBOE means thousand barrels of oil equivalent. So, $10.35\text{ MBOE} = 10.35 \times 1\,000\text{ BOE}$
$= 10\,350\text{ BOE.}$

MMBOE is a notation which has been adapted to mean million barrels of oil equivalent. So,

$$\begin{aligned} 0.2\text{ MMBOE} &= 0.2 \times 1\,000\,000\text{ BOE} \\ &= 200\,000\text{ BOE} \end{aligned}$$

while

$$\begin{aligned} 1.3\text{ MMBOE} &= 1.3 \times 1\,000\,000\text{ BOE} \\ &= 1\,300\,000\text{ BOE.} \end{aligned}$$

Exercises

Refer to table 1. Write what each entry means.

2. Computing with Units

A number is not enough to describe quantity. A word or phrase called unit or dimension must be associated with it to give it meaning. For instance, take the 1982 electric consumption to be 19 406 billion. This number does not make sense unless the phrase kilowatthours or kWh goes with it.

In solving problems, the units have to be carried along in the computations. As an example, to get 38.5% of the 1982 electric consumption, we don't just write 38.5% of 19 406. Instead we have 38.5% of 19 406 B kWh.

Units are treated as numbers. They can be cancelled so that the final answer will have no unit as desired or will have the proper unit. So in

$$\frac{7\,471.31\ \text{B kWh}}{3\,764.76\ \text{B kWh}}$$

B kWh in the numerator and denominator cancel out and we get 1.98.

Units can be multiplied. In

$$\frac{x}{0.2\ \text{million BOE}} = \frac{600\ \text{kWh}}{1\ \text{BOE}}$$

cross multiplication results in

$$x = \frac{0.2\ \text{million BOE} \times 600\ \text{kWh}}{1\ \text{BOE}}.$$

Then, $$x = \frac{(0.2)\,(600)\ \text{million}\ \cancel{(\text{BOE})}\ (\text{kWh})}{1\ \cancel{\text{BOE}}}$$

Cancelling BOE gives 120.0 M kWh, the desired answer.

Since units can be multiplied, then instead of writing 0.6 MMBOE − 0.2 MMBOE, we can just write (0.6 − 0.2) MMBOE. Likewise, 2.28 MBOE + 0.30 MBOE + 0.06 MBOE can be shortly written as (2.28 + 0.30 + 0.06) MBOE.

APPENDIX B

Additional tips for conserving electricity in the commercial and industrial groups.

Airconditioning

1. Avoid turning the thermostat on and off. A large amount of electricity is needed to make any electrical appliance start operating. Regulate the temperature properly.
2. Check the doors and windows of airconditioned rooms for leaks. Hot air can come in which the airconditioners must extract. Put curtains made of heavy materials on the windows or use blinds or shade to keep warm air and direct sunlight out of the windows.
3. Keep the airconditioner clean and in good running condition. This will help maximize its cooling ability.
4. Avoid frequent opening of doors. Minimize the traffic of people along the doorway. This will prevent hot air from getting in and cold air from getting out.
5. Place the airconditioners in the coolest side of the room. The best is usually the northern side, away from the morning and afternoon sun.
6. Switch off unused lighs in airconditioned rooms. Heat produced by lighting have to be removed by the airconditioners.
7. Use electric fans instead of airconditioners whenever possible and convenient.
8. Avoid smoking.

Lighting

1. Turn off lights when not needed.
2. Use the most efficient light source. For the same amount of power, say 40 watts, a fluorescent tube gives more than 5 times as much light as an incandescent bulb.

3. Use lamp lights efficiently by following these:

   a. Correct placement

      Bear in mind that dark surfaces absorb light while light colored walls and ceilings and bright surfaces reflect light.

   b. Regular maintenance

      Dust and dirt accumulating on lamps can cut down light output by as much as 50 percent. Clean lamps regularly to get more light from them.

   c. Efficient operation

      Inspect the lighting system periodically. Replace a bulb once it starts to dim.

   d. Use of timing or dimming devices

      These are devices that automatically turn the light on and off depending on the available amount of natural light.

4. Avoid excessive lighting. Use light fixtures which direct light exactly where it is needed such as track lights, spot lights and lamps in preference to general ceiling lights.

5. Turn off incandescent lights when leaving a room even if only for a few minutes. One can leave fluorescent lights switched on if he will return to the area within 15 minutes.

6. Replace yard or warehouse lighting system with low power sodium lamps.

Water Use

1. Water tanks should be designed such that frequent running of the water pump motor would be avoided.

2. Use water wisely. It takes electricity to pump, purify and deliver water to commercial buildings and industrial plants.

   a. Use wet rags instead of a garden hose in washing factory trucks.

b. Never let a faucet drip. One drip a second wastes 3 182.2 liters of water a year.

c. Use hot water properly.

d. Use the right amount of water for your needs. For instance, instead of letting water to gush from the faucet, use a glass when brushing your teeth.

Buying/Using Equipment

1. Buy an equipment that consumes electricity more efficiently.
2. Follow the manufacturer 's guides for the proper use and maintenance of electric equipment.
3. Disconnect transformers when not in use.
4. Switch off electric equipment when not being used.
5. Schedule large power-consuming activities for off-peak hours.

Using Nonconventional Sources of Energy

If possible use waste materials such as biogas as a source of heat. This possibility exists in some industries, say a meat processing firm that raises its own livestock. Biogas is an alcohol formed by the action of microorganisms on animal waste. It can be used as fuel.

ANSWERS TO QUESTIONS IN SELF-CHECK

1. Not necessarily. Recall the formula,

$$\text{Percentage} = \text{Percent} \times \text{Base}.$$

Similarly,

$$\text{Amount of increase} = \text{percent increase} \times \text{1984 electric use}$$

Study the relationship given in the formula. Note that the biggest percent increase may not yield the biggest amount of increase if the 1984 electric consumption is the smallest.

2. Energy from oil = 93% of 36.5 MMBOE
$= 0.93 \times 36.5$ MMBOE
$= 33.9$ MMBOE

Energy from non-oil sources = 7% of 36.5 MMBOE
$= 0.07 \times 36.5$ MMBOE
$= 2.6$ MMBOE

3. $$\frac{\text{1980 oil consumption}}{\text{1965 oil consumption}} = \frac{0.88 \times 91.8 \text{ MMBOE}}{0.93 \times 36.5 \text{ MMBOE}}$$

$$= \frac{80.78}{33.94}$$

$$= 2.40.$$

This is almost 2 1/2 times.

4. No, since the rates are the same but the bases are different.

5. $$\frac{(14.51 - 8.96) \text{ MMBOE}}{8.96 \text{ MMBOE}} \times 100\% = 61.94\%$$

6. Yes.

$$\frac{(9.54 - 7.64) \text{ MMBOE}}{7.64 \text{ MMBOE}} \times 100\% = 25.52\%$$

7. A 5% increase is equal to a 5% decrease. So the total consumption would increase by 0.86%.

8. New total consumption = (166.89 + 19 405.99) B kWh
= 19 572.88 B kWh

9. A 10% increase is equal to a 10% decrease. So the total consumption would increase by 1.72%.

10. The percent increase in the total consumption doubled when the use of the commercial sector increased from 5% to 10%.

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cover design: c.e. tongson